

REMARKS

The present application includes claims 1-20. Claims 1-20 were rejected by the Examiner.

Claims 1-10, 12-16, 19, and 20 were rejected under 35 U.S.C. 102(b) as being anticipated by Watanabe (U.S. Patent No. 6,325,537).

Watanabe relates to an X-ray diagnosis apparatus having a C-shaped arm, an X-ray detector and an X-ray generator such that the position and direction of the X-ray detector and the X-ray generator is freely changeable. See, e.g., Abstract. More specifically, Watanabe teaches an apparatus wherein the X-ray detector, the X-ray generator, and a bed upon which an object is placed change position or direction during a scan to control the positional relationship such that the object remains the center of the scan. See, e.g. Col. 2, Lines 17-18, 55-59, Col. 6, Lines 13-21. Watanabe does not teach or suggest a method for image reconstruction involving normalizing a magnification change. Instead, the variability of the position and direction of the X-ray detector and the X-ray generator are described as being used to keep the magnification ratio constant. See, e.g., Col. 3, Lines 17-18, 55-59, Col. 6, Lines 15-26. The claims of the present application recite such normalization of a magnification change.

As described in the application, one benefit of normalizing the change in magnification is to compensate for distortion and irregularity in images due to the non-isocentric motion. Watanabe fails to provide motivation for such a technique as well as

failing to disclose the non-isocentric motion in the first place. See, e.g. Col. 4, Lines 5-8. Watanabe does not form and maintain a virtual isocenter.

In current C-arm x-ray fluoroscopy imaging systems, a 3D tomographic image reconstruction may be performed by sweeping the C-arm in a semi-circular arc around an object of interest. Using cross-arm motion, the arc is circular and therefore isocentric. For example, using a C-arm, an x-ray beam may be swept around a head of a patient (e.g., a CT scan in a circular arc around the head). The volume image reconstruction is performed through 2D projection scan images. Sweeps are accomplished on cross-arm motion with the C-arm positioned at the head of a table sweeping around the head of the table. Thus, the object stays at the center (isocentric motion).

However, a view from a side of the patient or other object being imaged may result in motion occurring along a non-isocentric path. Performance of 3D tomographic reconstruction with an orbital motion of the C-arm is restricted because the paths of the x-ray source and detector are not isocentric. The object does not remain at the isocenter of the system. Resulting projection images are distorted due to the non-isocentric imaging arc and are unusable for clinical, diagnostic, or navigational purposes. The magnification change is quantified for the relationship between the volume of interest and the projection image(s). The magnification change data is used to adjust or normalize the image data to reconstruct the desired image(s) of the object. Thus, the pending claims provide a system and method facilitating 3D image reconstruction using a non-isocentric imaging arc and compensation for distortion and irregularity of the projection images due to non-isocentric motion.

Watanabe fails to provide motivation for such a technique. Instead, Watanabe provides support members to vary the position of the X-ray generator and X-ray detector so as to control the distances between the X-ray generator, the X-ray detector, and the scanned object. See, e.g., Col. 2, Lines 43-49. Watanabe describes one objective of such variability is to maintain a constant magnification ratio. See, e.g., Col. 3, Lines 60-64. Normalizing the change in magnification as recited in the claims of the present application alleviates the need to keep the magnification ratio constant, and thus the additional support member and its complicated linking mechanism of the Watanabe invention is unnecessary to meet the objectives of the present application. Even where Watanabe varies the ratio between the X-ray detector and the X-ray generator during a tomographic image generation embodiment there is no suggestion to normalize the magnification change, nor is there a suggestion to form and maintain a virtual isocenter. See, e.g. Col. 9, Lines 9-13. Furthermore, Watanabe makes no suggestion at all of a method or processor for reconstructing or adjusting image data to compensate for a change in magnification.

For at least these reasons, the Applicant respectfully submits that independent claims 1, 9, and 15 should be allowable over the cited art of record. Since claims 2-8, 10-14, and 16-20 depend from allowable claims 1, 9, and 15, respectively, the Applicant submits that claims 2-8, 10-14, and 16-20 should also be allowable over the cited art of record.

More specifically, with regard to dependent claims 2 and 10, Watanabe discusses providing an X-ray generator and an X-ray detector such that the position and direction of

both the X-ray generator and the X-ray detector are variable, but provides no mention of any sort of tracking or tracking system for both a detector and object position, as recited in claims 2 and 10. See, e.g., Col. 2, Lines 43-49.

With regard to claim 3, Watanabe mentions varying the incident angle between the X-ray detector, the object and the X-ray source varies, but not the distance between the object and detector and/or source to form a virtual isocenter between obtaining image exposures. See, e.g., Col. 9, lines 13-20. As described in the specification of the application, a virtual isocenter is formed by changing the detector to object distance during a non-isocentric sweep of a C-arm during a scan. See, e.g., Specification at ¶ 24.

With regard to claims 4 and 12, Watanabe discloses a means for setting a distance between a focal point of the X-ray generator and an X-ray detector, a means for keeping such distance constant and a means for displaying the set distance, but does not disclose determining a distance between the detector and the source, or the X-ray generator. See, e.g., Col. 3, Lines 55-59.

With regard to claim 8, Watanabe discloses three-dimensionally reconstructing projection images to obtain a 3D image, but fails to disclose basing said reconstruction on normalized magnification change. See, e.g. Col. 1, Lines 61-64.

Claims 11, 17, and 18 were rejected under 35 U.S.C. 103(a) as being unpatentable over Watanabe in view of Habraken et al. (U.S. Patent App. Pub. No. 2001/0031039). As discussed above, Watanabe fails to teach or reasonably suggest all the limitations of claims 9 and 15, from which claims 11 and 17-18 depend, respectively. Additionally, as noted by the Examiner, Watanabe fails to teach a method wherein a

tracking system comprises an electromagnetic tracking system for determining a position of a detector with respect to an object. In fact, Watanabe fails to disclose any tracking system. The Examiner points to Habraken for those limitations. However, Habraken simply provides an electromagnetic object sensor in order to prevent collisions between movable parts and, for example, a patient to be examined. See, e.g., Abstract. A tracking system is not recited in the pending claims to simply prevent collisions between movable parts. Rather, the tracking system aids in determining and monitoring detector and object position to establish a virtual isocenter and to adjust the obtained image data based on a change in magnification due to varying the distance between the object and the detector and/or source. A magnification change may be quantified and compensated for during tomographic image reconstruction using detector position and detector-to-object distance identified using the tracking system.

For at least these reasons, the Applicant respectfully submits that claims 11, 17, and 18 should be allowable over the cited art of record.

With regard to the Examiner's response to Applicant's arguments made on August 1, 2007 in response to the Office Action mailed May 1, 2007, the Applicant maintains that the claims of the present application are allowable over the cited references for the reasons provided in that response.

Finally, the Applicant submits that the pending claims are allowable over the art cited by the Examiner but not relied upon in his rejections (Hsieh, U.S. Patent No. 6,295,331, and Lewis, Jr., U.S. Patent No. 6,816,625).

CONCLUSION

The Applicants submit that the present application is in condition for allowance.

If the Examiner has any questions or the Applicants can be of any assistance, the Examiner is invited and encouraged to contact the Applicants at the number below.

The Commissioner is authorized to charge any additional fees or credit overpayment to the Deposit Account of GTC, Account No. 070845.

Respectfully submitted,

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